POSSIBLE EMPLACEMENT HISTORY OF A SANDBLOW STRUCTURE AT PALLETT CREEK, CALIFORNIA

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Detailed study of a pre-historic sandblow structure at Pallett Creek, California, indicates a complicated and enigmatic history of development.

The sandblow feature is located four meters west of the main trace of the San Andreas fault in a late Holocene section of peat and fluvial silt, sand and gravel (in exposure 5, Fig. 3, previous article, this volume). Elsewhere at the site, the strata containing the sandblow are characterized by minor faulting, disruption of the pre-historic surficial layer, and other liquefaction features which are interpreted by Sieh (1978) as evidence of a major earthquake in the 7th-century A.D.

The geometry and internal structure of the sandblow feature were determined by mapping a series of parallel vertical sections at a scale of 1:20 and study of a lacquer peel and thin sections. Representative vertical sections appear in Figures 1 and 2. Detailed observations of remarkably uniform laminations that persist throughout the feature were made in an effort to determine their importance in the evolution of the sandblow.

The feature consists of an elongated bathtub-shaped pit, below the 7th-century ground level, filled with laminated silt and sand. The pit is 1.5 m wide, 1.0 m deep and over 2 m long. Although the pit terminates abruptly at one end, its opposite end had not been excavated at this writing (May, 1979). The pit deposit and 7th-century surface are overlain by an extensive, poorly laminated, tabular sand body that varies from 10 to 50 cm in thickness, and appears to be contemporaneous with the pit sand.

Silt and clay, which in many places penetrate the host strata in tongues and stringers (see Figure 1/J), line the irregular but sharp and continuous pit boundaries (Figure 1/D). In section 5 (not shown) a coherent block of host peat, silt and sand is almost completely separated from the pit wall by a tongue of silt and clay. Despite such evidence of piece-meal excavation, no isolated chunks of host material were recognized in the pit deposit. The locally rounded form of the pit wall suggests that grain-by-grain erosion (Figure 1/I; Figure 2/11) accompanied removal of blocks (Figure 1/E).

The laminated pit deposit coarsens upward from silt and very find sand to medium and coarse sand. The pit laminations, defined by both grain size variation and alignment of platy minerals, are laterally continuous, concave upward, and spaced from 4 to 23 mm apart (Figure 2/7, 9). Spacing generally increases toward the center of the deposit (Figure 2/6). Laminations sharply abut the walls of the pit, are locally vertical, and enter embayments in the host strata (Figure 2/5). Concentrations of leafy debris, bark, charcoal, and seed pods occur directly beneath overhangs in the pit wall (Figure 2/10), and within laminations near the base of the deposit (Figure 2/8); no such material was found in the surrounding peat, silt, sand or gravel.

These observations are difficult to reconcile with any simple emplacement mechanism. Was the sand fill emplaced in the fluid state, or simply deposited rapidly in standing water? If deposited in standing water, how was the soft sediment in the overhanging walls supported? If the deposit was emplaced in the fluid state, how were the laminations, tongues and lining emplaced? Is the source of the pit filling the lower sand layer exposed in the excavated sections, or was the sand introduced from outside the pit? If the lower sand layer is the source, where did the plant litter come from, and where is the vent connecting the pit and the lower sand layer? If the sand was introduced from outside, why are there no chunks of the pit wall in the deposit? Could other nearby sandblows have introduced the sand via the ground surface? By what mechanism was the pit excavated, by water alone or sediment slurry? Was the pit excavated from below and filled from above or vice versa? Finally, how can these observations be reconciled with eye-witness accounts of sandblow formation during historic earthquakes?

Figure 3 illustrates a possible sequence of events in the formation of the sandblow. Movement on the fault (1) along which the sandblow was emplaced liquefied (2) the source sand layer and created a weak, fractured zone in overlying strata; the liquefied sand layer partially dewatered through overlying gravel "filter". Flow of water along base of impermeable layer and up to surface along weak zone widened fracture at highest flow locality (3). Undercutting and enlargement of pit by slumping. Removal of chunks of host and grain-by-grain erosion of pit. Alternate scouring and deposition of silt and clay at base of pit (4). Collapse of gravel layer through sand onto lower unit (5). Emplacement of liquid sand within the pit (6). Upward advance of liquefaction/solidification front and channellization (7). Deposition of silt and clay in tongues, pit lining and fine laminations (8). Accumulation of woody and leafy material (8). Compaction of sand and fluvial reworking (9).

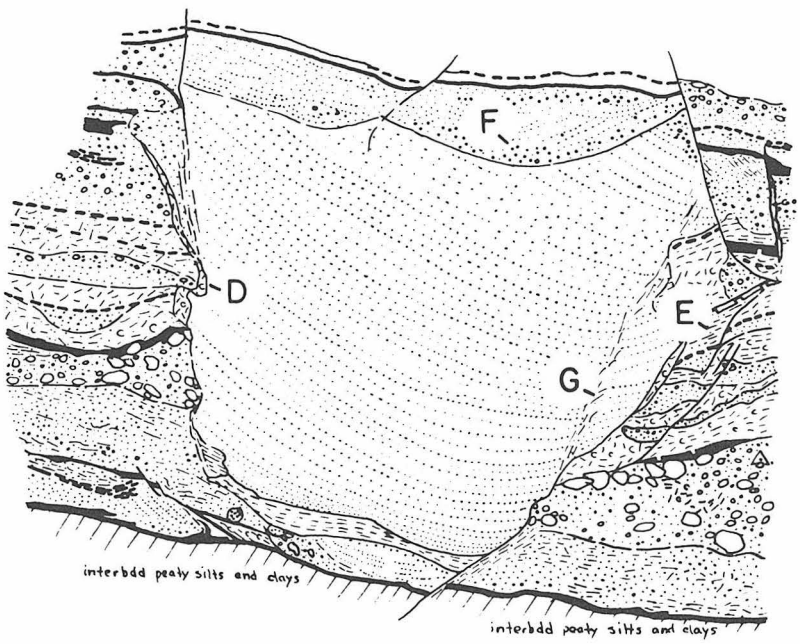
A moderate southeastward dip of the pit laminations, and a pronounced southeastward thinning of the tabular sand body, suggest a major source of

I METER

A. NO CHUNKS OF HOST IN PIT DEPOSIT

B. IRREGULAR, SHARP, CONTINUOUS PIT BOUNDARIES

C. PIT ELONGATED PERPENDICULAR TO SECTIONS

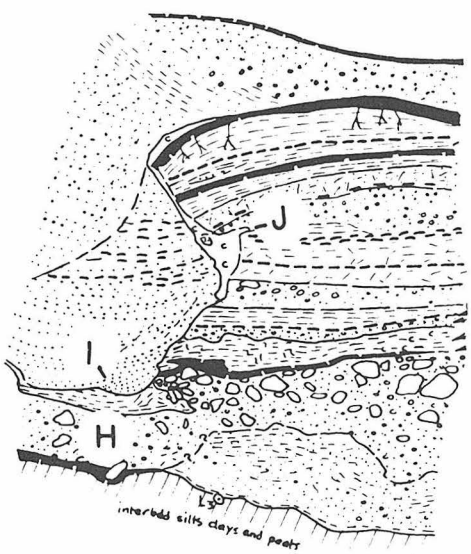


D. SILT AND CLAY LINING PIT

E. FAULT BLOCK MOVEMENT OF WALLS INTO PIT

F. CHANNEL STRUCTURES AT TOP

G. LITTLE SHEAR OF LAMINATIONS



H. DISRUPTION OF SAND & GRAVEL LAYER BENEATH PIT

I. SCOUR AT BASE IN SILTY CLAY UNIT

J. TONGUES OF SILT AND CLAY

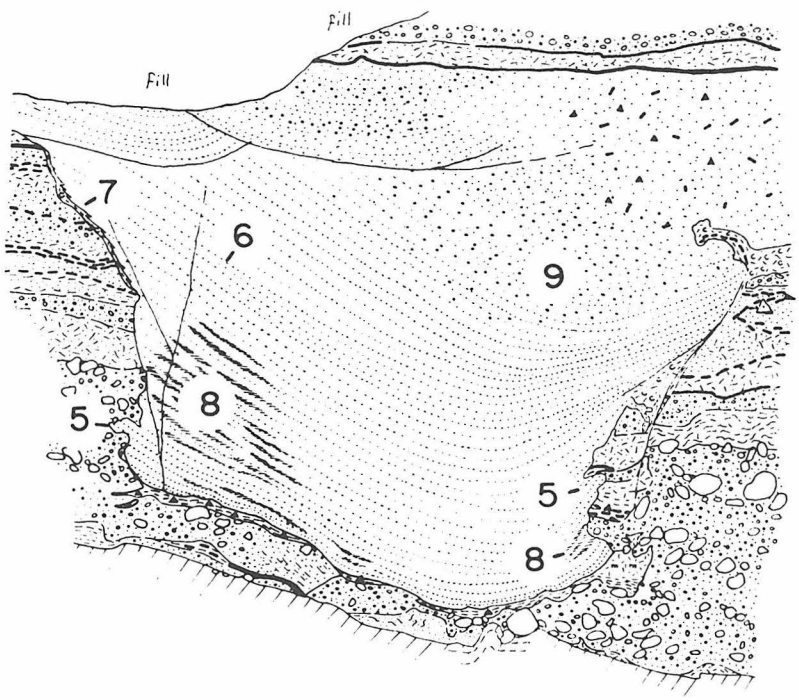
Figure 1. Pit structure -- 10 most critical observations (explanation accompanies Figure 3).

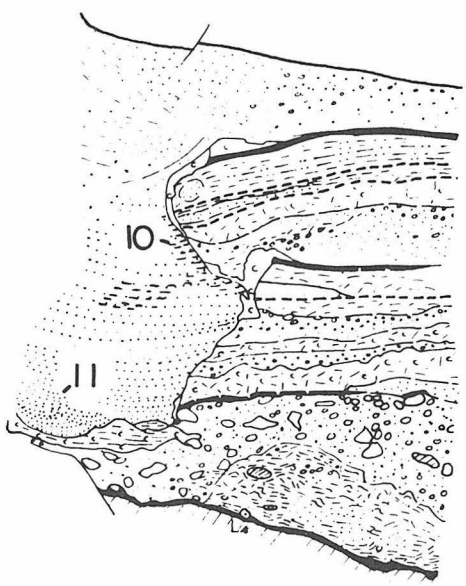
1. LAMINATIONS ARE CONCAVE UP

2. LAMINATION ARE LATERALLY CONTINUOUS

3. PLATY MINERALS ALIGNED

4. PIT DEPOSIT COARSENS UP





1 METER

5. LAMINATIONS SHARPLY ABUT BOUNDARY AND ENTER EMBAYMENTS

6. LAMINATION SPACING INCREASES TOWARD CENTER OF PIT

7. LAMINATIONS EXTEND INTO LATERAL SILT

8. LEAFY DEBRIS, BARK, CHARCOAL & SEED PODS FORM THICK LAM'S AT BASE OF PIT

9. LAMINATIONS IN UPPER PART OF PIT DEFINED BY GRAIN SIZE VARIATION

10. LEAFY DEBRIS, BARK, CHARCOAL & SEED PODS CONCENTRATED UNDER OVERHANG

11. SCOUR WITHIN SAND AT BASE

Figure 2. Pit laminations -- 11 most critical observations (explanation accompanies Figure 3).

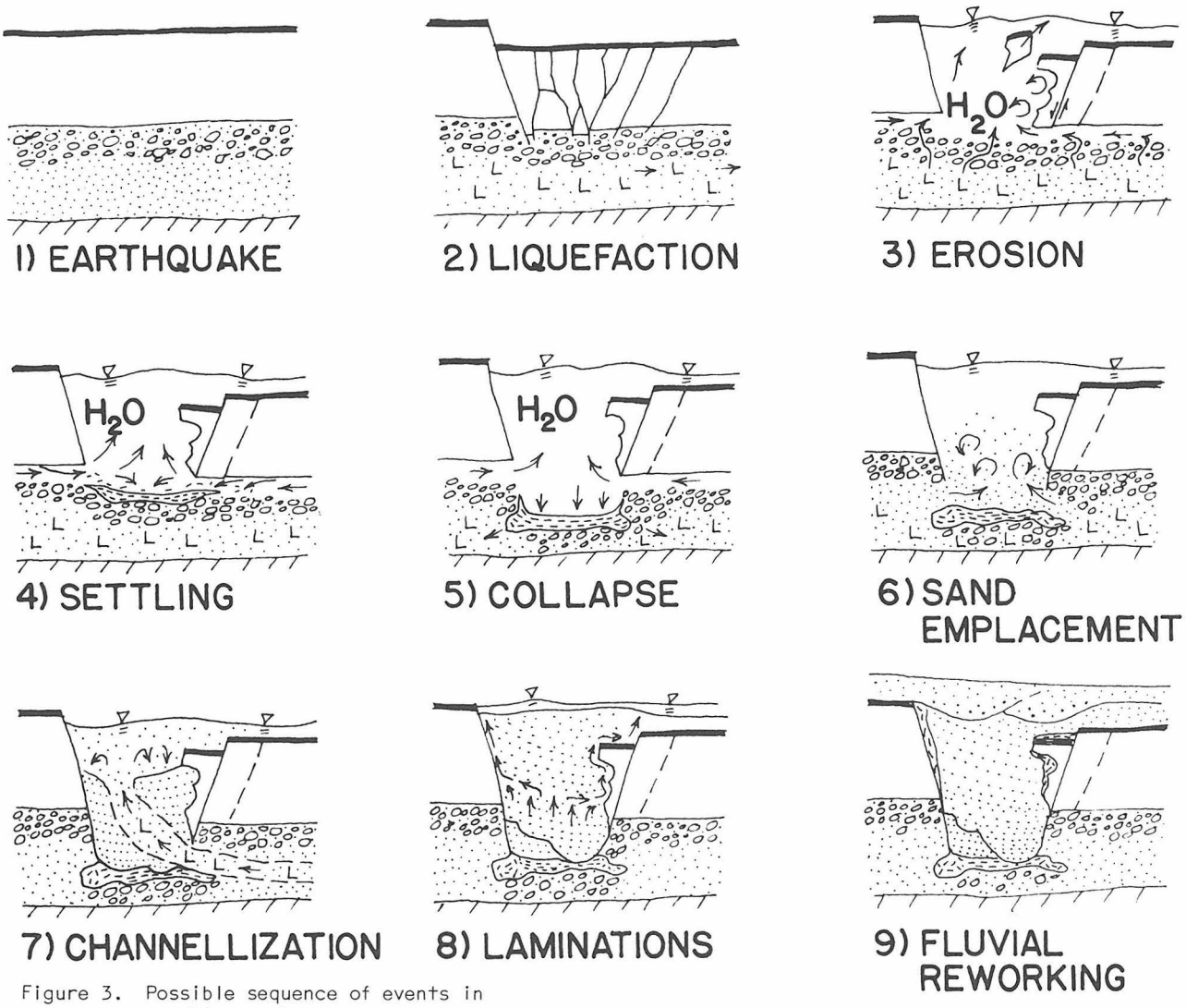


Figure 3. Possible sequence of events in sandblow emplacement.

sand located to the northwest in the unexcavated part of the sandblow. We expect to have excavation completed by the time of the field trip. Laminations may have formed during the upward advance of a liquefaction/solidification front and concomitant dewatering. Water, bearing elutriated fines and plant litter, could have flowed laterally toward the pit walls and then upward along them, depositing the silt and clay lining. Thus the observed laminations may represent a dewatering phenomenon not previously recognized in sedimentary deposits.

The value of liquefaction structures as indicators of pre-historic earthquakes will increase with greater understanding of their morphology and emplacement mechanisms. This study establishes a basis for systematic dissection and comparison of other naturally occurring sandblow deposits. Hopefully, one will be exposed at the time of the field trip. Future studies should be directed at modeling sandblow emplacement in the laboratory, and carefully recording sandblow occurrence, geometry and internal structure in the natural environment.